

Uncovering the Mysteries of Gray Mold

SCOTT BAUER (K9503-2)



A strawberry rachis completely engulfed by a gray mold fungus, *Botrytis cinerea*.

If you love strawberries, you've probably seen it. You pick out a luscious, ripe berry from the basket, only to turn it over and see a mound of yucky gray fuzz.

The fuzz, caused by gray mold (*Botrytis* sp.), ruins more than just strawberries. Over 23 species of *Botrytis* reduce yield, soften fruit, or affect color in a wide range of small fruits and nursery crops. In the Pacific Northwest alone, the mold causes up to \$125 million per year in crop losses.

Researchers at ARS' Horticultural Crops Laboratory in Corvallis, Oregon, have discovered new characteristics of the mold and powerful new control approaches that may help growers reduce *Botrytis* infection.

"Diseases caused by gray mold are among the most difficult to control," says ARS plant pathologist Walter F. Mahaffee. That's because the mold can remain dormant for long periods, waiting for environmental conditions to turn favorable. *Botrytis* grows well on dead or dying plant tissue, such as leaves, then spreads to live parts of the plant. It reproduces prolifically and produces spores at all stages of its life.

Recently, Mahaffee and colleagues at Oregon State University (OSU) in Corvallis discovered a new clue about *Botrytis*' success: The mold can also live as an epiphyte. That means mold spores germinate and grow unnoticed on the surface of leaves and other plant parts. That allows it to be present constantly until the perfect conditions arise for it to infect the plant and cause disease. This epiphytic growth appears to be why the disease spreads so rapidly.

"I'd look at a leaf before going home in the evening and it would look pretty healthy," says Mahaffee. "Then I'd come in the next day and two-thirds of the leaf would show signs of infection. That's a lot of area to be covered very fast."

He discovered that, in reality, *Botrytis* had completely colonized the leaf surface epiphytically. Then, when the time was right, the mold infected the leaf at multiple sites simultaneously. Mahaffee found that the mold could move from one leaf hair

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On this monitor, the *Botrytis cinerea* fungus on a plant specimen is easy to spot for research associate Caroline Press, of Oregon State University, and ARS plant pathologist Walter Mahaffee. The fungus glows green, thanks to green fluorescent protein technology.



Mahaffee (left) and Tom Verhoeven, president, Peoria Gardens, Inc., discuss uses of biological control agents to manage gray mold.

to the next without actually touching the leaf tissue itself.

"That type of spreading could reduce the efficacy of pesticides," he says, "because it would reduce the mold's contact with the residues on the leaves."

This finding was made possible by green fluorescent protein (GFP) technology. (See "Jellyfish Gene Lights Up *E. coli*," *Agricultural Research*, March 2000, p. 15.)

"By using this technology, we could watch the development of a single mold spore over time under the microscope," says Mahaffee. "We can also use a different GFP to mark a biological control agent and watch how the two organisms interact in real time. That's a first."

Taking Different Tacks

This work suggests new avenues for *Botrytis* control. "If we can determine the conditions that allow the mold to live in this epiphytic state, we may be able to make it harder for it to survive," says Mahaffee.

Growers use fungicides and biological control agents to keep the mold in check. But *Botrytis* quickly develops resistance to pesticides. Available biocontrols can help prevent infection, but they don't get rid of *Botrytis* once it is established.

Mahaffee's team recently found a new bacterium that may lead them to better biocontrols. A strain of *Burkholderia*, the bacterium eradicates even established gray mold on geranium leaves in the laboratory. Unfortunately, the bacterium is related to bacteria that can cause health concerns for cystic fibrosis patients. Although that is likely to preclude its development into a commercial biological control agent, it still gives the scientists new strategies to pursue.

"We may be able to identify the genes responsible for the bacterium's effectiveness and search for other bacteria that have similar genes. Or we may be able to move the genes into a harmless biocontrol organism," says Mahaffee. Another option: The researchers might be able to harvest the active compounds produced by the bacteria and use them to develop a pesticide.

But the most exciting discovery about the bacterium is that it forms a filmlike cluster of cells as it grows.

"This film seems to protect the bacterium from adverse conditions, like rapid or extreme changes in moisture or temperature," says Mahaffee. He and OSU plant pathologist Caroline Press found they could enhance this biofilm production by spraying the organisms onto the plant in a mixture of natural polymers already used as food additives.

"Adding polymers to the *Burkholderia* gives the same biological control of *Botrytis*, but at a much lower bacterial concentration," Mahaffee says. And the polymer mixture helps with other biocontrols, too.

"Adding the polymer to some existing biological control agents gave us *Botrytis* control in the greenhouse where there was none without the polymers, or it improved control of other agents," he says. Mahaffee suspects that the polymers help organisms colonize a leaf surface better, giving them a higher, more constant population to stave off gray mold.

While this technology is just now being developed, Mahaffee hopes it could find commercial application with growers in 5 to 7 years, giving consumers firmer fruit and brighter flowers.—
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This research is part of Plant Diseases, an ARS National Program (#303) described on the World Wide Web at <http://www.nps.ars.usda.gov>.

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Botrytis cinerea sporulation on a ripe strawberry.